Mass transport and structural relaxation in metallic melts: benefits from scattering techniques and experiments under microgravity

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We study mass transport and structural relaxation in metallic glass-forming melts, in order to understand how microscopic mechanisms and processes control the properties of these melts. This requires accurate experimental data on e.g. self-diffusion coefficients and liquid viscosity over large temperature ranges, particularly in the metastable, undercooled state, which become only accessible employing containerless processing techniques combined with large-scale facilities at synchrotron and neutron sources, as well as experiments under microgravity conditions.

Using these data, we show that in these alloy melts the self-diffusion coefficients and the liquid viscosity exhibit very similar temperature dependencies, despite different chemical short-range orders of the alloys, indicating that the dynamic properties of the melt are governed by a single structural relaxation timescale. However, concerning their temperature dependence, a mismatch between the high and low temperature melt dynamics can be found in the undercooled liquid region, commonly known as a strong-fragile transition. The timescale of the transition is on the order of tens of seconds, which points to a mechanism requiring long range mass transport, distinct from that reported in the oxides, water or other liquids.